SEQUENCE LISTING

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Kobbe, Daniela
Zhu, Zhenyu
Samuelson, James

<120> Methods for Altering the Cleavage Specificity of a Type II Restriction Endonuclease

<130> NEB-183-CIP

<150> 10/150,028
<151> 2002-05-17

<150> 09/693,146
<151> 2000-07-02

<160> 26

<170> PatentIn version 3.2

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tat tac acc cct aaa gtt att gct gac ttt tta tgt caa tgg agt att   96
Tyr Tyr Thr Pro Lys Val Ile Ala Asp Phe Leu Cys Gln Trp Ser Ile
             20                  25                  30

caa gat gac aca aag agt gta ctt gaa ccc agt tgt gga gat ggt aat   144
Gln Asp Asp Thr Lys Ser Val Leu Glu Pro Ser Cys Gly Asp Gly Asn
         35                  40                  45

ttt att gaa tcg gca ata ctt agg ttc aaa gaa ctt agt ata gat aat   192
Phe Ile Glu Ser Ala Ile Leu Arg Phe Lys Glu Leu Ser Ile Asp Asn
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gaa caa ctt aaa gga aga att aca gga gta gag cta att gaa gaa gaa   240
Glu Gln Leu Lys Gly Arg Ile Thr Gly Val Glu Leu Ile Glu Glu Glu
 65                  70                  75                  80

gct ttg aaa gtt caa aat cga gca aat gag ttg ggg gtt gat aaa aac   288
Ala Leu Lys Val Gln Asn Arg Ala Asn Glu Leu Gly Val Asp Lys Asn
                 85                  90                  95

tca ata gta aat agt gac ttc ttt caa ttt gta aaa gat aat aag aat   336
Ser Ile Val Asn Ser Asp Phe Phe Gln Phe Val Lys Asp Asn Lys Asn
            100                 105                 110

aaa aaa ttt gat act att att ggt aat cca cca ttc ata aga tac caa   384
Lys Lys Phe Asp Thr Ile Ile Gly Asn Pro Pro Phe Ile Arg Tyr Gln
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        115                 120                 125

aac ttt cct gaa gag cat cgt agt ata gcc atg gaa atg atg gag gaa   432
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cta ggt tta aaa cct aat aaa ctt aca aat atc tgg gtt cca ttt cta   480
Leu Gly Leu Lys Pro Asn Lys Leu Thr Asn Ile Trp Val Pro Phe Leu
145                 150                 155                 160

gtg gta tct gct aca tta ctt aat gaa caa gga aag atg gct atg gtt   528
Val Val Ser Ala Thr Leu Leu Asn Glu Gln Gly Lys Met Ala Met Val
                165                 170                 175

ata ccg gct gaa tta ttt cag gta aag tat gca gca gaa aca aga att   576
Ile Pro Ala Glu Leu Phe Gln Val Lys Tyr Ala Ala Glu Thr Arg Ile
            180                 185                 190

ttt tta tca aag ttt ttc gat cgt atc act ata att aca ttt gaa aaa   624
Phe Leu Ser Lys Phe Phe Asp Arg Ile Thr Ile Ile Thr Phe Glu Lys
        195                 200                 205

ctt gtt ttt gaa aat atc caa cag gaa gtt ata cta ctt ctt tgt gaa   672
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    210                 215                 220

aag aaa gtt aat aaa ggt aaa gga att cgg gtt att gaa tgc gag aac   720
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225                 230                 235                 240

tta gat gga tta aat tcc att gat ttt gta gct ata aat ggt tca aat   768
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gtt aaa cct att gaa cac cgt act gaa aag tgg aca aag tat ttc tta   816
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aac gaa gat gaa ata ctt ctt tta cag agt tta aag gaa gac aaa cgc   864
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gtt aaa aat tgt aat gac tat ttt aag aca gaa gtt ggc tta gtt act   912
Val Lys Asn Cys Asn Asp Tyr Phe Lys Thr Glu Val Gly Leu Val Thr
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gga cga aac gaa ttc ttt atg atg aaa gaa aac caa gta aaa gaa tgg   960
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aat cta gaa gaa tat aca ata cct gtt aca ggt agg tcc aat cag tta  1008
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tta ccg att gag tgt caa aat tat atc aag tat ggg gaa gaa aaa ggc   1152
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ttc cat caa ggc tat aaa acc aga att aga aaa cgt tgg tat ata act   1200
Phe His Gln Gly Tyr Lys Thr Arg Ile Arg Lys Arg Trp Tyr Ile Thr
385                 390                 395                 400

cca tct aga tgg gtt cca gat gct ttt gct tta aga cag gtt gat ggc   1248
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tat cca aaa cta att tta aat gaa acc gac gct tct tct act gat aca   1296
Tyr Pro Lys Leu Ile Leu Asn Glu Thr Asp Ala Ser Ser Thr Asp Thr
            420                 425                 430

att cat agg gtt aga ttt aaa gaa ggt ata aat gaa aag tta gcc gta   1344
Ile His Arg Val Arg Phe Lys Glu Gly Ile Asn Glu Lys Leu Ala Val
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gtt tca ttt ttg aac tca ctc act ttt gca tct tca gaa ata acg ggg   1392
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    450                 455                 460

aga agt tat ggt ggt ggt gtt atg aca ttc gaa cca act gaa att gga   1440
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465                 470                 475                 480

gaa atc cta ata cct tcc ttt gat aac tta tcc att gat ttt gat aaa   1488
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att gat gcc tta att cga gaa aag gag att gaa aaa gtc ctt gat att   1536
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            500                 505                 510

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gta aaa cag ctt cga ggg ata tgg aag aaa ctt tct cag aga aga aac   1632
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             20                  25                  30

Gln Asp Asp Thr Lys Ser Val Leu Glu Pro Ser Cys Gly Asp Gly Asn
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 65                  70                  75                  80

Ala Leu Lys Val Gln Asn Arg Ala Asn Glu Leu Gly Val Asp Lys Asn
                 85                  90                  95

Ser Ile Val Asn Ser Asp Phe Phe Gln Phe Val Lys Asp Asn Lys Asn
            100                 105                 110

Lys Lys Phe Asp Thr Ile Ile Gly Asn Pro Pro Phe Ile Arg Tyr Gln
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Asn Phe Pro Glu Glu His Arg Ser Ile Ala Met Glu Met Met Glu Glu
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Val Val Ser Ala Thr Leu Leu Asn Glu Gln Gly Lys Met Ala Met Val
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Ile Pro Ala Glu Leu Phe Gln Val Lys Tyr Ala Ala Glu Thr Arg Ile
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Phe Leu Ser Lys Phe Phe Asp Arg Ile Thr Ile Ile Thr Phe Glu Lys
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Leu Val Phe Glu Asn Ile Gln Gln Glu Val Ile Leu Leu Leu Cys Glu
    210                 215                 220

Lys Lys Val Asn Lys Gly Lys Gly Ile Arg Val Ile Glu Cys Glu Asn
225                 230                 235                 240

Leu Asp Gly Leu Asn Ser Ile Asp Phe Val Ala Ile Asn Gly Ser Asn
                245                 250                 255

Val Lys Pro Ile Glu His Arg Thr Glu Lys Trp Thr Lys Tyr Phe Leu
            260                 265                 270

Asn Glu Asp Glu Ile Leu Leu Leu Gln Ser Leu Lys Glu Asp Lys Arg
        275                 280                 285

Val Lys Asn Cys Asn Asp Tyr Phe Lys Thr Glu Val Gly Leu Val Thr
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Gly Arg Asn Glu Phe Phe Met Met Lys Glu Asn Gln Val Lys Glu Trp
305                 310                 315                 320

Asn Leu Glu Glu Tyr Thr Ile Pro Val Thr Gly Arg Ser Asn Gln Leu
                325                 330                 335

Lys Gly Ile Thr Phe Thr Glu Asn Asp Phe His Glu Asn Ser Met Glu
            340                 345                 350

Gln Lys Ala Ile His Leu Phe Leu Pro Pro Asp Glu Asp Phe Glu Lys
        355                 360                 365
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Leu Pro Ile Glu Cys Gln Asn Tyr Ile Lys Tyr Gly Glu Glu Lys Gly
    370                 375                 380

Phe His Gln Gly Tyr Lys Thr Arg Ile Arg Lys Arg Trp Tyr Ile Thr
385                 390                 395                 400

Pro Ser Arg Trp Val Pro Asp Ala Phe Ala Leu Arg Gln Val Asp Gly
                405                 410                 415

Tyr Pro Lys Leu Ile Leu Asn Glu Thr Asp Ala Ser Ser Thr Asp Thr
            420                 425                 430

Ile His Arg Val Arg Phe Lys Glu Gly Ile Asn Glu Lys Leu Ala Val
        435                 440                 445

Val Ser Phe Leu Asn Ser Leu Thr Phe Ala Ser Ser Glu Ile Thr Gly
    450                 455                 460

Arg Ser Tyr Gly Gly Gly Val Met Thr Phe Glu Pro Thr Glu Ile Gly
465                 470                 475                 480

Glu Ile Leu Ile Pro Ser Phe Asp Asn Leu Ser Ile Asp Phe Asp Lys
                485                 490                 495

Ile Asp Ala Leu Ile Arg Glu Lys Glu Ile Glu Lys Val Leu Asp Ile
            500                 505                 510

Val Asp Glu Ala Leu Leu Ile Lys Tyr His Gly Phe Ser Glu Lys Glu
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Asn Arg Thr Lys Lys
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  1               5                  10                  15

ttt tta aaa cca act tat aat gaa act caa cta agg aat gat ttt ata   96
Phe Leu Lys Pro Thr Tyr Asn Glu Thr Gln Leu Arg Asn Asp Phe Ile
             20                  25                  30

gac cca ctt cta aaa tct tta gga tgg gat gtt gat aat acc aaa gga   144
Asp Pro Leu Leu Lys Ser Leu Gly Trp Asp Val Asp Asn Thr Lys Gly
         35                  40                  45

aaa aca cat att cta aga gat gtc att caa gaa gaa tac ata gaa ata   192
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Lys Thr His Ile Leu Arg Asp Val Ile Gln Glu Glu Tyr Ile Glu Ile
     50                  55                  60

aaa gat gag gag aca aag aaa aat cca gat tat aca ctt cgt ata aac   240
Lys Asp Glu Glu Thr Lys Lys Asn Pro Asp Tyr Thr Leu Arg Ile Asn
 65                  70                  75                  80

ggt acg aga aag ctg ttt gta gag gtt aag aaa ccg tct ttt aat att   288
Gly Thr Arg Lys Leu Phe Val Glu Val Lys Lys Pro Ser Phe Asn Ile
                85                  90                  95

ttg aaa tca gct aaa gca gcc ttc caa aca aga aga tat ggt tgg agt   336
Leu Lys Ser Ala Lys Ala Ala Phe Gln Thr Arg Arg Tyr Gly Trp Ser
            100                 105                 110

gct aac ctt ggt att tca gta ctt aca aat ttc gag cat cta gtt att   384
Ala Asn Leu Gly Ile Ser Val Leu Thr Asn Phe Glu His Leu Val Ile
        115                 120                 125

tat gat tgt aga tat acg cct gac aaa tcc gac aat gaa cat att gct   432
Tyr Asp Cys Arg Tyr Thr Pro Asp Lys Ser Asp Asn Glu His Ile Ala
    130                 135                 140

aga tat aaa gtt ttc tct tac gag gaa tat gaa gaa gca ttt gat gaa   480
Arg Tyr Lys Val Phe Ser Tyr Glu Glu Tyr Glu Glu Ala Phe Asp Glu
145                 150                 155                 160

ata aag gat ata att tca tat gag tca gcc aac tca ggt gct ctg gac   528
Ile Lys Asp Ile Ile Ser Tyr Glu Ser Ala Asn Ser Gly Ala Leu Asp
                165                 170                 175

gaa atg ttt gat gta aat aca aga gtt ggt gaa acg ttt gac gag tat   576
Glu Met Phe Asp Val Asn Thr Arg Val Gly Glu Thr Phe Asp Glu Tyr
            180                 185                 190

ttt tta cag caa att gag aat tgg cgc gaa aag cta gct aaa act gca   624
Phe Leu Gln Gln Ile Glu Asn Trp Arg Glu Lys Leu Ala Lys Thr Ala
        195                 200                 205

att aaa aat aac acc gaa tta ggt gaa gag gac gtc aat ttt att gtc   672
Ile Lys Asn Asn Thr Glu Leu Gly Glu Glu Asp Val Asn Phe Ile Val
    210                 215                 220

caa aga cta tta aac aga att att ttt ctt aga gtt tgt gaa gat aga   720
Gln Arg Leu Leu Asn Arg Ile Ile Phe Leu Arg Val Cys Glu Asp Arg
225                 230                 235                 240

acc att gaa aaa tat gaa aca att aaa agt ata aaa aac tat gag gaa   768
Thr Ile Glu Lys Tyr Glu Thr Ile Lys Ser Ile Lys Asn Tyr Glu Glu
                245                 250                 255

tta aaa gat ctg ttt caa aag tct gat agg aaa ttt aat tca ggt ctc   816
Leu Lys Asp Leu Phe Gln Lys Ser Asp Arg Lys Phe Asn Ser Gly Leu
            260                 265                 270

ttt gac ttc ata gat gat acg ctc ttg ctt gag gtt gaa att gat tcg   864
Phe Asp Phe Ile Asp Asp Thr Leu Leu Leu Glu Val Glu Ile Asp Ser
        275                 280                 285

aat gta ttg ata gaa att ttt agt gat tta tat ttc cca caa agc cca   912
Asn Val Leu Ile Glu Ile Phe Ser Asp Leu Tyr Phe Pro Gln Ser Pro
    290                 295                 300
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tat gat ttt tct gtt gtc gat cca aca ata tta agc cag ata tat gaa   960
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305                 310                 315                 320

cgt ttt cta ggt caa gaa ata att ata gag tca ggt ggt aca ttt cac   1008
Arg Phe Leu Gly Gln Glu Ile Ile Ile Glu Ser Gly Gly Thr Phe His
                325                 330                 335

att acg gag tca cca gaa gtt gcg gcg tcc aat ggt gtt gtt cca act   1056
Ile Thr Glu Ser Pro Glu Val Ala Ala Ser Asn Gly Val Val Pro Thr
            340                 345                 350

cca aaa att atc gtc gaa cag ata gtg aaa gac act tta acg ccc ctt   1104
Pro Lys Ile Ile Val Glu Gln Ile Val Lys Asp Thr Leu Thr Pro Leu
        355                 360                 365

acg gaa ggc aaa aaa ttt aat gag cta tgt aac tta aaa ata gca gat   1152
Thr Glu Gly Lys Lys Phe Asn Glu Leu Cys Asn Leu Lys Ile Ala Asp
    370                 375                 380


ata tgt tgt gga tca gga act ttc cta att tca agt tat gac ttt cta   1200
Ile Cys Cys Gly Ser Gly Thr Phe Leu Ile Ser Ser Tyr Asp Phe Leu
385                 390                 395                 400

gta gag aaa gta atg gaa aag ata ata gaa gag aac atc gat gat tca   1248
Val Glu Lys Val Met Glu Lys Ile Ile Glu Glu Asn Ile Asp Asp Ser
                405                 410                 415

gat tta gta tat gaa act gaa gaa ggg cta att ttg aca ctt aaa gca   1296
Asp Leu Val Tyr Glu Thr Glu Glu Gly Leu Ile Leu Thr Leu Lys Ala
            420                 425                 430

aaa aga aat atc ttg gag aat aat ttg ttt ggt gtt gat gtt aat cca   1344
Lys Arg Asn Ile Leu Glu Asn Asn Leu Phe Gly Val Asp Val Asn Pro
        435                 440                 445

tac gct gtt gaa gta gct gag ttc agt tta tta tta aag cta tta gaa   1392
Tyr Ala Val Glu Val Ala Glu Phe Ser Leu Leu Leu Lys Leu Leu Glu
    450                 455                 460

ggt gag aat gag gca tcg gtt aat aat ttc att cac gag cat gag gat   1440
Gly Glu Asn Glu Ala Ser Val Asn Asn Phe Ile His Glu His Glu Asp
465                 470                 475                 480

aaa ata tta ccg gat tta aca tct att att aaa tgt gga aac agc tta   1488
Lys Ile Leu Pro Asp Leu Thr Ser Ile Ile Lys Cys Gly Asn Ser Leu
                485                 490                 495

gta gat aat aag ttt ttt gaa ttc atg cca gaa tcg tta gag gac gat   1536
Val Asp Asn Lys Phe Phe Glu Phe Met Pro Glu Ser Leu Glu Asp Asp
            500                 505                 510

gaa atc tta ttt aag gct aat cca ttt gaa tgg gaa gag gag ttt cca   1584
Glu Ile Leu Phe Lys Ala Asn Pro Phe Glu Trp Glu Glu Glu Phe Pro
        515                 520                 525

gat att atg gca aat ggt ggc ttt gat gct att ata gga aat cca cct   1632
Asp Ile Met Ala Asn Gly Gly Phe Asp Ala Ile Ile Gly Asn Pro Pro
    530                 535                 540

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                565                 570                 575

gtt gac aag tat ttt tta ttt att gag aga gca tta ata tta ctc aat   1776
Val Asp Lys Tyr Phe Leu Phe Ile Glu Arg Ala Leu Ile Leu Leu Asn
            580                 585                 590

cct act ggg ctg ttg ggt tat ata ata ccg cat aaa ttc ttt att aca   1824
Pro Thr Gly Leu Leu Gly Tyr Ile Ile Pro His Lys Phe Phe Ile Thr
        595                 600                 605


aaa ggt ggt aag gaa cta aga aag ttc ata gct gaa aaa cat caa ata   1872
Lys Gly Gly Lys Glu Leu Arg Lys Phe Ile Ala Glu Lys His Gln Ile
    610                 615                 620

tca aaa att ata aat ttt ggt gtt aca cag gtc ttt cca gga aga gcg   1920
Ser Lys Ile Ile Asn Phe Gly Val Thr Gln Val Phe Pro Gly Arg Ala
625                 630                 635                 640

aca tat acg gct att tta att atc caa gca aat aaa atg gca cag ttc   1968
Thr Tyr Thr Ala Ile Leu Ile Ile Gln Ala Asn Lys Met Ala Gln Phe
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aag tat aag aaa gta agt aat ata tca gca gaa acc cta gat tct gaa   2016
Lys Tyr Lys Lys Val Ser Asn Ile Ser Ala Glu Thr Leu Asp Ser Glu
            660                 665                 670

gaa aat acg tgt gtt tat agc tca gaa aag tat aat tct gac cct tgg   2064
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        675                 680                 685

ata ttt tta tct cct gaa aca gaa gct gtt ttt act aaa ttt aca gaa   2112
Ile Phe Leu Ser Pro Glu Thr Glu Ala Val Phe Thr Lys Phe Thr Glu
    690                 695                 700

gct caa ttt gag aaa ctt gga gaa atc act gat ata agt gta gga cta   2160
Ala Gln Phe Glu Lys Leu Gly Glu Ile Thr Asp Ile Ser Val Gly Leu
705                 710                 715                 720

caa aca agc gct gat aaa ata tat att ttt att cct gaa aat gaa act   2208
Gln Thr Ser Ala Asp Lys Ile Tyr Ile Phe Ile Pro Glu Asn Glu Thr
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Ser Asp Thr Tyr Ile Phe Asn Tyr Lys Gly Lys Arg Tyr Glu Ile Glu
            740                 745                 750

aaa tct ata tgt tgc cca gct atc tat gac tta tct ttt ggt tct ttt   2304
Lys Ser Ile Cys Cys Pro Ala Ile Tyr Asp Leu Ser Phe Gly Ser Phe
        755                 760                 765

gaa agc att cag gga aat gca caa atg ata ttc cct tat gaa atc aga   2352
Glu Ser Ile Gln Gly Asn Ala Gln Met Ile Phe Pro Tyr Glu Ile Arg
    770                 775                 780

gat gaa gaa gca tat cta cta gag gaa gaa acg ctt gaa aat gat tat   2400
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785                 790                 795                 800
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                805                 810                 815

aga agc tta caa ggc cgt aat ccg aaa tgg tat caa tat ggt cgg tcc   2496
Arg Ser Leu Gln Gly Arg Asn Pro Lys Trp Tyr Gln Tyr Gly Arg Ser
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caa agt tta tca aaa ttt cat gat aaa gaa aaa ctg ata tgg acc gta   2544
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        835                 840                 845

ctt gct acg aaa ccc ccg tat gta ctt gat agg aat aac ctg tta ttt   2592
Leu Ala Thr Lys Pro Pro Tyr Val Leu Asp Arg Asn Asn Leu Leu Phe
    850                 855                 860

act ggt ggt gga aac gga ccg tat tat ggt tta att aac caa tct att   2640
Thr Gly Gly Gly Asn Gly Pro Tyr Tyr Gly Leu Ile Asn Gln Ser Ile
865                 870                 875                 880

tac tct ttg cat tat ttt tta ggt att ctt tca cat cct gta ata gaa   2688
Tyr Ser Leu His Tyr Phe Leu Gly Ile Leu Ser His Pro Val Ile Glu
                885                 890                 895

agt atg gta aaa gca agg gcc agt gaa ttt agg gga tca tat tat tct   2736
Ser Met Val Lys Ala Arg Ala Ser Glu Phe Arg Gly Ser Tyr Tyr Ser
            900                 905                 910

cat gga aaa caa ttt att gag aaa atc cca att aga aag att gat ttt   2784
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gat gat caa gat gag gta gac aaa tat aat acg gtg gtc aca aca gta   2832
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    930                 935                 940

gaa aaa tta att ata act acc gat aga att aaa agt gag agc aat gga   2880
Glu Lys Leu Ile Ile Thr Thr Asp Arg Ile Lys Ser Glu Ser Asn Gly
945                 950                 955                 960

ccc cgg agg aga atg tta aga aga agg tta gat gct ttg tct aat caa   2928
Pro Arg Arg Arg Met Leu Arg Arg Arg Leu Asp Ala Leu Ser Asn Gln
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ctt atc cag gtt att aat gaa ctt tat aat atc agt gac gaa gaa tat   2976
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acg aca gtt ttg aat gat gaa atg ttg aca gcg gcg tta gga gaa gaa   3024
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Lys Thr His Ile Leu Arg Asp Val Ile Gln Glu Glu Tyr Ile Glu Ile
     50                  55                  60

Lys Asp Glu Glu Thr Lys Lys Asn Pro Asp Tyr Thr Leu Arg Ile Asn
 65                  70                  75                  80

Gly Thr Arg Lys Leu Phe Val Glu Val Lys Lys Pro Ser Phe Asn Ile
                 85                  90                  95

Leu Lys Ser Ala Lys Ala Ala Phe Gln Thr Arg Arg Tyr Gly Trp Ser
            100                 105                 110

Ala Asn Leu Gly Ile Ser Val Leu Thr Asn Phe Glu His Leu Val Ile
        115                 120                 125

Tyr Asp Cys Arg Tyr Thr Pro Asp Lys Ser Asp Asn Glu His Ile Ala
    130                 135                 140

Arg Tyr Lys Val Phe Ser Tyr Glu Glu Tyr Glu Glu Ala Phe Asp Glu
145                 150                 155                 160

Ile Lys Asp Ile Ile Ser Tyr Glu Ser Ala Asn Ser Gly Ala Leu Asp
                165                 170                 175

Glu Met Phe Asp Val Asn Thr Arg Val Gly Glu Thr Phe Asp Glu Tyr
            180                 185                 190

Phe Leu Gln Gln Ile Glu Asn Trp Arg Glu Lys Leu Ala Lys Thr Ala
        195                 200                 205

Ile Lys Asn Asn Thr Glu Leu Gly Glu Glu Asp Val Asn Phe Ile Val
    210                 215                 220

Gln Arg Leu Leu Asn Arg Ile Ile Phe Leu Arg Val Cys Glu Asp Arg
225                 230                 235                 240

Thr Ile Glu Lys Tyr Glu Thr Ile Lys Ser Ile Lys Asn Tyr Glu Glu
                245                 250                 255

Leu Lys Asp Leu Phe Gln Lys Ser Asp Arg Lys Phe Asn Ser Gly Leu
            260                 265                 270

Phe Asp Phe Ile Asp Asp Thr Leu Leu Leu Glu Val Glu Ile Asp Ser
        275                 280                 285
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Asn Val Leu Ile Glu Ile Phe Ser Asp Leu Tyr Phe Pro Gln Ser Pro
    290                 295                 300

Tyr Asp Phe Ser Val Val Asp Pro Thr Ile Leu Ser Gln Ile Tyr Glu
305                 310                 315                 320

Arg Phe Leu Gly Gln Glu Ile Ile Ile Glu Ser Gly Gly Thr Phe His
                325                 330                 335

Ile Thr Glu Ser Pro Glu Val Ala Ala Ser Asn Gly Val Val Pro Thr
            340                 345                 350

Pro Lys Ile Ile Val Glu Gln Ile Val Lys Asp Thr Leu Thr Pro Leu
        355                 360                 365

Thr Glu Gly Lys Lys Phe Asn Glu Leu Cys Asn Leu Lys Ile Ala Asp
    370                 375                 380

Ile Cys Cys Gly Ser Gly Thr Phe Leu Ile Ser Ser Tyr Asp Phe Leu
385                 390                 395                 400

Val Glu Lys Val Met Glu Lys Ile Ile Glu Glu Asn Ile Asp Asp Ser
                405                 410                 415

Asp Leu Val Tyr Glu Thr Glu Glu Gly Leu Ile Leu Thr Leu Lys Ala
            420                 425                 430

Lys Arg Asn Ile Leu Glu Asn Asn Leu Phe Gly Val Asp Val Asn Pro
        435                 440                 445

Tyr Ala Val Glu Val Ala Glu Phe Ser Leu Leu Leu Lys Leu Leu Glu
    450                 455                 460

Gly Glu Asn Glu Ala Ser Val Asn Asn Phe Ile His Glu His Glu Asp
465                 470                 475                 480

Lys Ile Leu Pro Asp Leu Thr Ser Ile Ile Lys Cys Gly Asn Ser Leu
                485                 490                 495

Val Asp Asn Lys Phe Phe Glu Phe Met Pro Glu Ser Leu Glu Asp Asp
            500                 505                 510

Glu Ile Leu Phe Lys Ala Asn Pro Phe Glu Trp Glu Glu Glu Phe Pro
        515                 520                 525

Asp Ile Met Ala Asn Gly Gly Phe Asp Ala Ile Ile Gly Asn Pro Pro
    530                 535                 540

Tyr Val Arg Ile Gln Asn Met Lys Lys Tyr Ser Pro Glu Glu Ile Glu
545                 550                 555                 560

Tyr Tyr Gln Ser Lys Asp Ser Glu Tyr Thr Val Ala Lys Lys Glu Thr
                565                 570                 575

Val Asp Lys Tyr Phe Leu Phe Ile Glu Arg Ala Leu Ile Leu Leu Asn
            580                 585                 590

Pro Thr Gly Leu Leu Gly Tyr Ile Ile Pro His Lys Phe Phe Ile Thr
        595                 600                 605

Lys Gly Gly Lys Glu Leu Arg Lys Phe Ile Ala Glu Lys His Gln Ile
    610                 615                 620
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Ser Lys Ile Ile Asn Phe Gly Val Thr Gln Val Phe Pro Gly Arg Ala
625                 630                 635                 640

Thr Tyr Thr Ala Ile Leu Ile Ile Gln Ala Asn Lys Met Ala Gln Phe
                645                 650                 655

Lys Tyr Lys Lys Val Ser Asn Ile Ser Ala Glu Thr Leu Asp Ser Glu
            660                 665                 670

Glu Asn Thr Cys Val Tyr Ser Ser Glu Lys Tyr Asn Ser Asp Pro Trp
        675                 680                 685

Ile Phe Leu Ser Pro Glu Thr Glu Ala Val Phe Thr Lys Phe Thr Glu
    690                 695                 700

Ala Gln Phe Glu Lys Leu Gly Glu Ile Thr Asp Ile Ser Val Gly Leu
705                 710                 715                 720

Gln Thr Ser Ala Asp Lys Ile Tyr Ile Phe Ile Pro Glu Asn Glu Thr
                725                 730                 735

Ser Asp Thr Tyr Ile Phe Asn Tyr Lys Gly Lys Arg Tyr Glu Ile Glu
            740                 745                 750

Lys Ser Ile Cys Cys Pro Ala Ile Tyr Asp Leu Ser Phe Gly Ser Phe
        755                 760                 765

Glu Ser Ile Gln Gly Asn Ala Gln Met Ile Phe Pro Tyr Glu Ile Arg
    770                 775                 780

Asp Glu Glu Ala Tyr Leu Leu Glu Glu Glu Thr Leu Glu Asn Asp Tyr
785                 790                 795                 800

Pro Leu Ala Trp Asn Tyr Leu Asn Glu Phe Lys Glu Ala Leu Glu Lys
                805                 810                 815

Arg Ser Leu Gln Gly Arg Asn Pro Lys Trp Tyr Gln Tyr Gly Arg Ser
            820                 825                 830

Gln Ser Leu Ser Lys Phe His Asp Lys Glu Lys Leu Ile Trp Thr Val
        835                 840                 845

Leu Ala Thr Lys Pro Pro Tyr Val Leu Asp Arg Asn Asn Leu Leu Phe
    850                 855                 860

Thr Gly Gly Gly Asn Gly Pro Tyr Tyr Gly Leu Ile Asn Gln Ser Ile
865                 870                 875                 880

Tyr Ser Leu His Tyr Phe Leu Gly Ile Leu Ser His Pro Val Ile Glu
                885                 890                 895

Ser Met Val Lys Ala Arg Ala Ser Glu Phe Arg Gly Ser Tyr Tyr Ser
            900                 905                 910

His Gly Lys Gln Phe Ile Glu Lys Ile Pro Ile Arg Lys Ile Asp Phe
        915                 920                 925

Asp Asp Gln Asp Glu Val Asp Lys Tyr Asn Thr Val Val Thr Thr Val
    930                 935                 940

Glu Lys Leu Ile Ile Thr Thr Asp Arg Ile Lys Ser Glu Ser Asn Gly
945                 950                 955                 960
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Pro Arg Arg Arg Met Leu Arg Arg Arg Leu Asp Ala Leu Ser Asn Gln
965 970 975

Leu Ile Gln Val Ile Asn Glu Leu Tyr Asn Ile Ser Asp Glu Glu Tyr
980 985 990

Thr Thr Val Leu Asn Asp Glu Met Leu Thr Ala Ala Leu Gly Glu Glu
995 1000 1005

Lys

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